

REMARKS

Claims 1, 5, 7, 16, and 18 have been amended. Claims 40-50 have been added to round out the scope of the invention. No new matter has been added. Claims 1-8, 16-20, and 40-50 are pending in the application.

Claims 1-8 and 16-20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,780,666 (McClure) in view of U.S. Patent No. 6,362,040 (Tews). The rejection is respectfully traversed.

The present invention is directed to an imaging device pixel cell having a halogen-rich region formed therein for suppressing dark current in a photosensor. Accordingly, independent claim 1, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate [and] an isolation region formed within said substrate and adjacent to said photosensor.” Claim 1 further recites that the pixel cell has “a halogen-rich region localized at least at a sidewall region of said isolation region.”

Independent claim 16, as amended, recites a pixel cell having “a semiconductor substrate having trenches formed therein [and] a photosensor formed in said substrate and having a first doped region and a second doped region in association with said semiconductor substrate, said photosensor being capable of generating dark current.” Claim 16 further recites the pixel cell having “a halogen-rich region formed in a top surface of said substrate for the suppression of said dark current; and an isolation region formed within said trenches of said semiconductor substrate.”

McClure relates to an imaging device having a pixel with two capacitors in series. (Abstract). McClure fails to teach each and every limitation of claims 1 and 16, as admitted by the Office Action. Specifically, McClure fails to teach or suggest a pixel cell having “a halogen-rich region localized at least at a sidewall region of said isolation region,” as recited by claim 1. Similarly, McClure fails to teach or suggest a pixel cell having “a halogen-rich region formed in a top surface of said substrate for the suppression of said dark current,” as recited by claim 16.

The Office Action improperly combines McClure with Tews to allegedly arrive at the claimed invention. Tews relates to the fabrication of memory devices and transistors. Specifically, Tews relates to “a method for growing a dielectric layer on a substrate [by] . . . providing a substrate having at least two crystallographic planes which experience different dielectric layer growth rates.” (Abstract). The different growth rates are a result of doping the surface at which the thermal oxide is intended to be grown. Tews, col. 7, ll. 18-27.

Tews does not teach or suggest “a halogen-rich region localized at least at a sidewall region of [an] isolation region,” as recited by claim 1. Similarly, Tews fails to teach or suggest “a halogen-rich region formed in a top surface of said substrate for the suppression of said dark current,” as recited by claim 16.

Pixel cells are typically formed between two isolation regions to prevent crosstalk between adjacent pixel cells in an array. Isolation regions are intended to separate two electronic devices, e.g., pixel cells in the invention, to prevent any interference from adjacent cells. Tews does not teach or suggest “halogen-rich region localized at least at a sidewall region of [an] *isolation region*” that serves to isolate two electronic devices from one another. Indeed, the trench relied upon by the Office Action as a “halogen-rich region localized at least at a sidewall region of [an] *isolation region*” is filled by growing an oxide layer therein, subsequently resulting in a vertical transistor, i.e., an electronic device. Therefore, the Office Action’s reliance on Tews as a “halogen-rich region localized at least at a sidewall region of [an] *isolation region*” is incorrect, and the references, alone or in combination, fail to teach or suggest the claimed invention.

Similarly, Tews does not teach or suggest “a halogen-rich region formed in a top surface of said substrate for the suppression of said dark current; and an isolation region formed within said trenches of said semiconductor substrate.” As discussed above, the doped region of Tews’ trench is filled with an oxide layer, resulting in the formation of a vertical transistor. Therefore, the references, alone or in combination, fail to teach or suggest the claimed invention.

Significantly, neither McClure nor Tews is directed to the problem of dark current generation in an imaging device, or the use of a halogen-rich region to suppress dark current. McClure relates to increasing the capacitance of a charge collection region, and Tews relates to

varying the growth rate of a substrate at different surfaces. Neither reference even mentions the problem of the present invention addresses, namely, dark current generation in an imaging device pixel cell.

Moreover, the Office Action engages in impermissible hindsight in combining the two references. Courts have generally recognized that a showing of a prima facie case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. *See e.g., In re Dembiczak*, 175 F.3d 994 (Fed. Cir. 1999); *In re Rouffet*, 149 F.3d 1350, 1355 (Fed. Cir. 1998); *Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc.*, 75 F.3d 1568, 1573 (Fed. Cir. 1996); and MPEP § 706.02(j) and 2143 *et seq.* Furthermore, the “[t]he teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant’s disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).” MPEP § 706.02(j).

The Office Action fails to provide any suggestion or motivation to combine the two references, as required by MPEP §§ 706.02(j) and 2143 *et seq.* Instead, the Office Action merely makes the assertion that “it would have been obvious to one of ordinary skill in the art at the time the invention was made to have a halogen-rich region for oxidizing trench sidewalls which reduces crystallographic orientation dependence,” by using Applicant’s disclosure as a guide. (Office Action at 3, ¶3). As discussed above, Tews dopes a localized surface of a silicon substrate to vary the growth rates at which thermal oxide will grow. Tews, col. 7, ll. 18-27. It would not have been obvious to one of ordinary skill in the art to combine Tews with McClure, as McClure relates to an imaging device having a pixel cell with two capacitors in series.

Accordingly, Applicant respectfully submits that claims 1 and 16 are allowable over the combination of McClure and Tews. Claims 2-8, claims 17-20, and new dependent claims 40-43 depend from claims 1 and 16, and are allowable for at least the reasons set forth above, and on their own merit.

New independent claim 44 recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate [and] a shallow trench isolation region formed within said substrate and adjacent to said photosensor.” Claim 41 further recites the pixel cell having “a fluorine-rich region localized at least at a sidewall region of said shallow trench isolation region.”

New independent claim 45 recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; a shallow trench isolation region formed within said substrate; and; and a halogen-rich region localized at least at a sidewall region of said shallow trench isolation region for suppressing the flow of dark current from said photosensor.”

New independent claim 48 recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; an isolation region formed within said substrate; and a halogen-rich region localized at least at a sidewall region of said isolation region for suppressing the presence of charge collecting dangling bonds of said substrate at the sidewall region..”

For the reasons set forth above, the two references, alone or in combination, fail to teach each and every limitation of claims 44, 45, or 48. For at least these reasons, claims 44, 45, and 48 are allowable over Tews and McClure. New dependent claims 46, 47, 49, and 50 depend from claims 45 and 48, and are allowable for at least the reasons set forth above, and on their own merit.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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